7. SCENARIOS WITH EARLY RECEIPT STARTING IN 2007

This section describes the analysis results for 13 implementation scenarios that begin acceptance of wastes before 2010. The scenarios were formulated with the start of waste receipt at repository facilities in 2007. The impacts of starting waste receipt in 2008 were also estimated.

The scenarios are described in Section 7.1, and an overview of their cost and effectiveness is provided in Section 7.2. A more comprehensive analysis of 5 of the 13 implementation scenarios is presented in Section 7.3. The analysis encompasses annual costs, total system life cycle cost, utility costs, societal cost, and the ability to avoid the need for new utility dry storage sites.

Detailed tabulations of annual costs are given in Appendix D for each of the implementation scenarios described in this section.

7.1 DESCRIPTION OF POTENTIAL SCENARIOS

Characteristics of the 13 scenarios are summarized in Table 7-1. All scenarios place commercial SNF into storage in surface facilities at the repository.

Scenarios 9 through 12 are analogous to scenarios 1 and 2 for receipt starting in 2010. They employ modular surface facilities and the mostly legal weight truck transportation alternative at the beginning of waste acceptance. The mostly rail alternative is added later. Scenarios 9, 10, and 12 start with implementation of the smallest WHB module in 2007. Scenario 11 is similar to scenario 9, but the initial WHB module is the augmented WHB-1 that has enhanced capability for receiving canisters, and the mostly rail alternative is completed by 2009. The construction costs before 2010 are $1.59B, $1.97B, $2.50B, and $2.80B (05$) for scenarios 9 through 12 respectively.

Scenario 13 is similar to scenario 12, but it includes rail for Nevada transportation at the beginning of waste acceptance, 2 years earlier than for scenario 12. Scenario 14 is similar to scenario 13, except that all deferred modules are completed by 2009. It has the largest receipt rates of all of the scenarios. The receipt rates are those identified in S. 104 and HR 1270. The construction costs before 2010 are $2.80B and $3.47B (05$) for scenarios 13 and 14, respectively.

Scenarios 15 through 19 and 21 utilize the small transport construction cost alternative at the beginning of waste acceptance. Their receipt rates, therefore, are limited only by repository surface facility capabilities. The first waste receipt facility in scenario 15 is a canister facility that is located at the CPB area. A dry transfer facility is also included to supply the capability for contingencies that require recovering spent fuel from the storage area. Scenario 19 is the other scenario that employs a waste receipt facility in the CPB area starting in 2007. This facility is an enhanced dry transfer facility that would unload uncanistered SNF from either legal weight truck casks or large casks. The construction costs before 2010 are $1.93B, $1.85B, $1.78B, $2.23B, $1.93B and $1.78B (05$) for scenarios 15-19 and 21, respectively.

Table 7-1. Early Receipt Implementation Scenarios

Scenario for Early Receipt starting in 2007	Carrier Preparation Area (in 2007)	Initial Modules available in 2007 and 2010: Waste Handling Building	Balance of Plant (in 2007)	Underground (in 2010)	Nevada Transportation Alternative (in 2007)	Year complete	Leveled Annual Costs ($M)	Year Increase in funds is needed	Leveled Annual Cost to avoid increase in funds before 2021 ($M)	Total System Life Cycle Cost with acceptance starting in 2007 ($B-98$)
9: Modular with mostly legal weight truck and early receipt	Reference design	WHB-1 in 2007, and WHB-2 in 2010	Service contracts and temporary facilities	5,000 MTHM	Mostly legal weight truck	Mostly Rail: 2019, Subsurface: 2015, Surface: 2019	$845	2015	$940	$45.0
10: Modular surface with mostly legal weight truck and early receipt	Reference design	WHB-1 in 2007, and WHB-2 in 2010	Service contracts and temporary facilities	Reference design	Mostly legal weight truck	Mostly Rail: 2017, WHB: 2018	$925	2015	$995	$45.0
11: Augmented modular with mostly legal weight truck in 2007 and mostly rail in 2010	Reference design	Augmented WHB-1 in 2007, and WHB-2 in 2010	Service contracts and temporary facilities	5,000 MTHM	Mostly legal weight truck	WHB: 2017, Subsurface: 2015, Mostly Rail: 2009	$1,055	2018	$1,060	$45.2
12: Modular surface with mostly legal weight truck in 2007 and mostly rail in 2010	Reference design	WHB-1 in 2007, and WHB-2 in 2010	Service contracts and temporary facilities	Reference design	Mostly legal weight truck	WHB: 2012, Mostly Rail: 2009	$1,090	2012	$1,105	$44.6
13: Modular surface with mostly rail in 2007	Reference design	WHB-1 in 2007, and WHB-2 in 2010	Service contracts and temporary facilities	Reference design	Mostly Rail	WHB: 2012	$1,120	N/A	$1,120	$44.5
14: Modular surface with mostly rail and highest rate early receipt	Reference design	WHB-1 in 2007, all in 2010	Service contracts and temporary facilities	Reference design	Mostly Rail	All in 2009	$1,255	N/A	$1,255	$45.0
15: Modular with separate canister facility, small transport construction cost and early receipt	Canister facility	WHB-1 and WHB-2 in 2010	Service contracts and temporary facilities	5,000 MTHM	Small transport construction cost	Subsurface: 2015, WHB: 2018	$1,015	2016	$1,055	$46.3

Table 7-1. Early Receipt Implementation Scenarios (Continued)

Scenario for Early Receipt starting in 2007	Carrier Preparation Area (in 2007)	Initial Modules available in 2007 and 2010				Year complete	Leveled Annual Costs ($M)	Year Increase in funds is needed	Leveled Annual Cost to avoid increase in funds before 2021 ($M)	Total System Life Cycle Cost with acceptance starting in 2007 ($B-98$)
		Waste Handling Building	Balance of Plant (in 2007)	Underground (in 2010)	Nevada Transportation Alternative (in 2007)					
16: Augmented modular with small transport construction cost and early receipt	Reference design	Augmented WHB-1 in 2007, and WHB-2 in 2010	Service contracts and temporary facilities	5,000 MTHM	Small transport construction cost	Subsurface 2015, WHB: 2015	$1,050	2015	$1,075	$46.5
17: Modular with small transport construction cost and minimal rate early receipt	Reference design	WHB-1 in 2007, and WHB-2 in 2010	Service contracts and temporary facilities	5,000 MTHM	Small transport construction cost	WHB: 2016, Subsurface: 2015	$890	2016	$950	$44.7
18: Augmented modular surface with small transport construction cost and high initial rate early receipt	Reference design	Augmented WHB-1 in 2007, and WHB-2 in 2010	Service contracts and temporary facilities	Reference	Small transport construction cost	WHB: 2013	$1,105	2012	$1,115	$45.4
19: Modular with separate dry transfer facility, small transport construction cost and low rate early receipt	Enhanced DTS	WHB-1 and WHB-2 in 2010	Service contracts and temporary facilities	5,000 MTHM	Small transport construction cost	Subsurface 2017, WHB: 2018	$885	2020	$900	$45.5
20: Modular with mostly rail and moderate initial rate early receipt	Reference design	WHB-1 in 2007, and WHB-2 in 2010	Service contracts and temporary facilities	5,000 MTHM	Mostly Rail	WHB: 2012, Subsurface: 2013	$1,060	2012	$1,085	$44.5
21: Modular with small transport construction cost and enhanced low rate early receipt	Reference design	WHB-1 in 2007, and WHB-2 in 2010	Service contracts and temporary facilities	5,000 MTHM	Small transport construction cost	Subsurface: 2017, WHB: 2016	$915	2020	$922	$45.2

Scenarios 16 and 18 both employ the augmented WHB-1 that has enhanced canister receipt capability. The two scenarios differ in the first module of the underground facility. Scenario 16 employs the 5,000 MTHM module, and scenario 18 employs the reference design.

Scenarios 17 and 21 employ the same phasing of surface facility modules. They differ only in the annual waste acceptance receipt rates. The acceptance rates for scenario 17 are limited to the ACR rates until 2012 in order to place emphasis on completion of deferred modules. Waste acceptance rates for scenario 21 are increased to put emphasis on preventing new utility dry storage sites.

Scenario 20 and scenario 17 utilize the same modularization of the WHB and the subsurface facility. The scenarios differ in the Nevada transportation alternative. Scenario 20 utilizes mostly rail, and scenario 17 utilizes the small transport construction cost alternative. The construction costs before 2010 are $2.43B (05$) for scenario 20.

Leveled annual costs and adjusted leveled annual costs are shown in Table 7-1 for each scenario. The leveled annual cost ensures that no increase over the corresponding target cost profile will be needed until after 2010. The year in which an increase would be needed over the target cost is also shown in Table 7-1. The adjusted leveled annual cost is the leveled annual cost that ensures that no increase over the target cost profile will be needed until after 2020. Leveled annual costs and adjusted leveled annual costs are described in Section 2.1.

CRWMS total system life cycle costs are also provided for each scenario in Table 7-1.

The commercial SNF receipt rates for each of the implementation scenarios are shown in Table 7-2. These waste acceptance rates were selected to be consistent with the objective of maintaining costs within the target cost profile as described in Section 2.1. The scenarios were structured to emphasize picking up as much commercial SNF as possible.

Each implementation scenario also included the receipt of canisters of naval SNF, DOE SNF, high-level waste without immobilized plutonium, and canisters of high-level waste with immobilized plutonium.

Underground emplacement was limited in scenarios that employed the 5,000 MTHM subsurface facility. The rates were selected to be consistent with transitioning from emplacement in the first module to emplacement in the second module without stopping emplacement operations. Commercial SNF was stored on the surface in scenarios with differences between waste receipt rates and underground emplacement rates.

Table 7-2. Rates of Acceptance of Commercial Spent Nuclear Fuel for Early Receipt Implementation Scenarios - 2007 Pickup

Scenario	Receipt Rates for Commercial SNF (MTHM per year)														Total MTHM
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
9: Modular with mostly legal weight truck and early receipt	400	600	900	900	900	900	900	900	900	1500	1500	1500	1500	3000	16300
10: Modular surface with mostly legal weight truck and early receipt	400	600	900	900	900	1300	1300	1300	1300	1300	1300	2000	3000	3000	19500
11: Augmented modular with mostly legal weight truck in 2007 and mostly rail in 2010	400	600	900	1200	2000	2000	2000	2000	2000	2000	3000	3000	3000	3000	27100
12: Modular surface with mostly legal weight truck in 2007 and mostly rail in 2010	400	600	900	1200	1500	2000	3000	3000	3000	3000	3000	3000	3000	3000	30600
13: Modular surface with mostly rail in 2007	400	600	900	1200	1200	2000	3000	3000	3000	3000	3000	3000	3000	3000	30300
14: Modular surface with mostly rail and highest rate early receipt	1200	1200	2000	2000	2700	3000	3000	3000	3000	3000	3000	3000	3000	3000	36100
15: Modular with separate canister facility, small transport construction cost and early receipt	1200	1200	2000	2000	2000	2000	2000	2000	2000	2000	3000	3000	3000	3000	30400
16: Augmented modular with small transport construction cost and early receipt	1200	1200	2000	2000	2000	2000	2000	2000	2000	2000	3000	3000	3000	3000	30400
17: Modular with small transport construction cost and minimal rate early receipt	400	600	900	900	900	900	1200	1200	1200	1200	2200	3000	3000	3000	20600
18: Augmented modular surface with small transport construction cost and high initial rate early receipt	1200	1200	2000	2000	2000	2000	2000	3000	3000	3000	3000	3000	3000	3000	33400
19: Modular with separate dry transfer facility, small transport construction cost and low rate early receipt	400	600	700	1200	1200	1200	1200	1200	1200	1200	1200	2000	3000	3000	19300
20: Modular with mostly rail and moderate initial rate early receipt	450	800	1200	1200	1300	2000	3000	3000	3000	3000	3000	3000	3000	3000	30950
21: Modular with small transport construction cost and enhanced low rate early receipt	450	800	1200	1200	1300	1300	1300	1300	1300	1300	1300	2000	3000	3000	20750

7.2 OVERVIEW OF EFFECTIVENESS AND LIFE CYCLE COSTS

An overview of the effectiveness of the early receipt implementation scenarios is shown in Figures 7-1 to 7-4. Figures 7-1 and 7-2 illustrate the amounts of commercial SNF accepted between 2007 and 2020. The type of leveled annual cost differs for the two figures. Figures 7-3 and 7-4 show the potential capability to empty shutdown reactor pools between 2007 and 2020 if utilities choose to assign priority to shutdown reactors. Figure 7-3 shows the potential capability if early receipt is started in 2007, and Figure 7-4 shows the potential capability if early receipt is started in 2008.

The amounts of naval SNF, DOE SNF, high-level waste with immobilized plutonium, and high-level waste without immobilized plutonium accepted are shown in Table 7-3 for the prioritization method described in Section 2.2.1. The small numbers of DOE SNF canisters shown for scenarios 9, 10, 15, 16, 19 and 21 could be larger with an alternative prioritization method.

The relationships between cost and effectiveness are similar for both the amounts of commercial SNF accepted and the capability to empty shutdown reactor pools. The following relationships were obtained from comparisons of cost and effectiveness shown in Figures 7-1 through 7-4 and in Table 7-3:

- Use of the enhanced dry transfer system as the first module incurs smaller leveled annual costs than use of the smallest waste handling building module, WHB-1, without significantly reducing the amount of commercial SNF picked up through 2020. This relationship is obtained from comparing scenario 19 with scenarios 17 and 21.

- Use of the enhanced dry transfer system as the first module instead of WHB-1 results in less acceptance of naval SNF because canisters of naval SNF cannot be accepted until 2010. This result is obtained from comparing the effectiveness of scenario 19 with the effectiveness of scenarios 17 and 21 in Table 7-3.

- Deferral of the mostly rail alternative or small transport construction cost alternative could result in acceptance of less naval SNF because currently planned canisters are too large to be transported by legal weight truck. The impacts are illustrated by comparing scenarios 9 and 10 with scenario 13.

- Substantial increases in effectiveness are provided by the increased canister receipt capacity of either the augmented WHB-1 or the canister transfer facility at the carrier preparation area. The leveled annual costs for comparable scenarios with the separate canister transfer facility are smaller than for scenarios with only the augmented WHB-1. These relationships were obtained by comparing scenarios 15, 16, and 21.

- The potential capability to empty pools at shutdown reactors is reduced if receipt is started in 2008 instead of 2007. The reduction is one to five pools depending on the scenario.

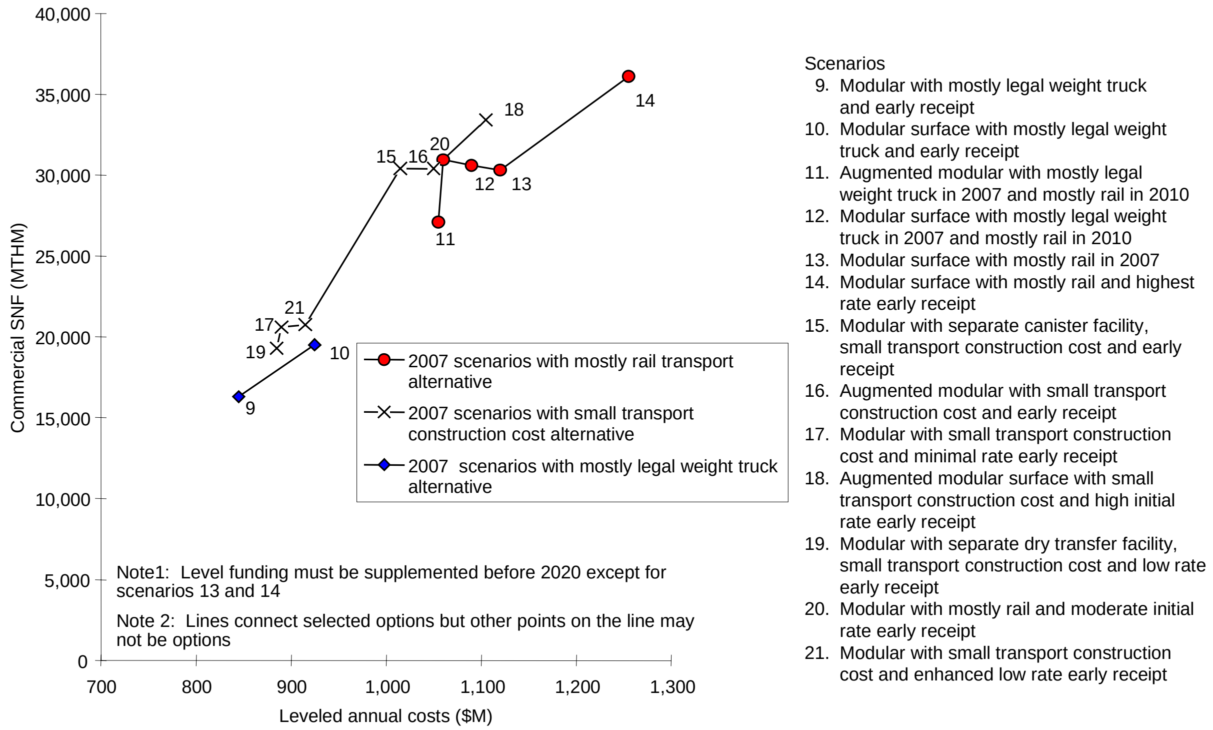


Figure 7-1. Acceptance of Commercial Spent Nuclear Fuel from 2007 through 2020

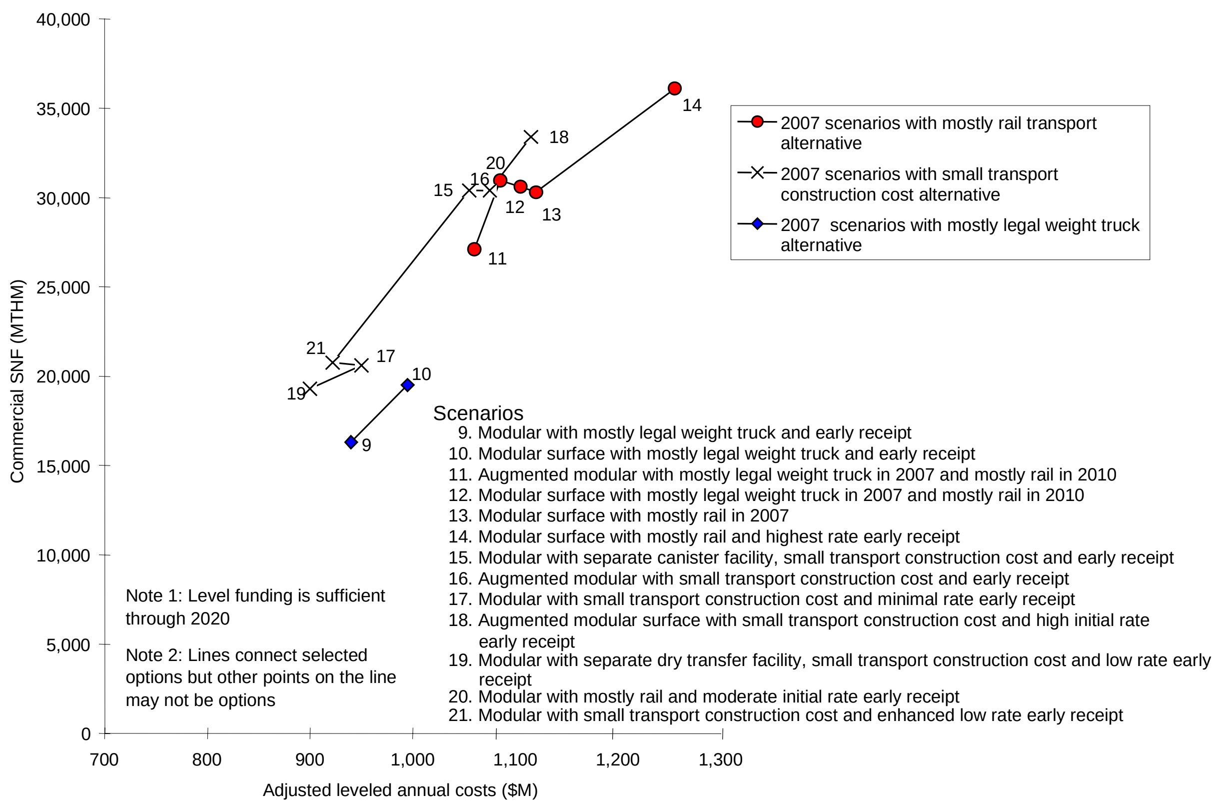
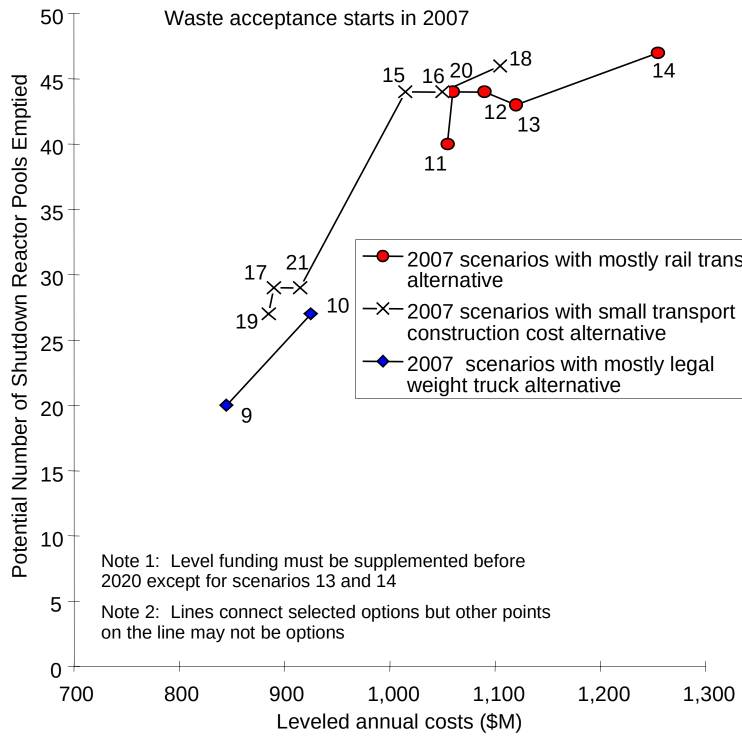


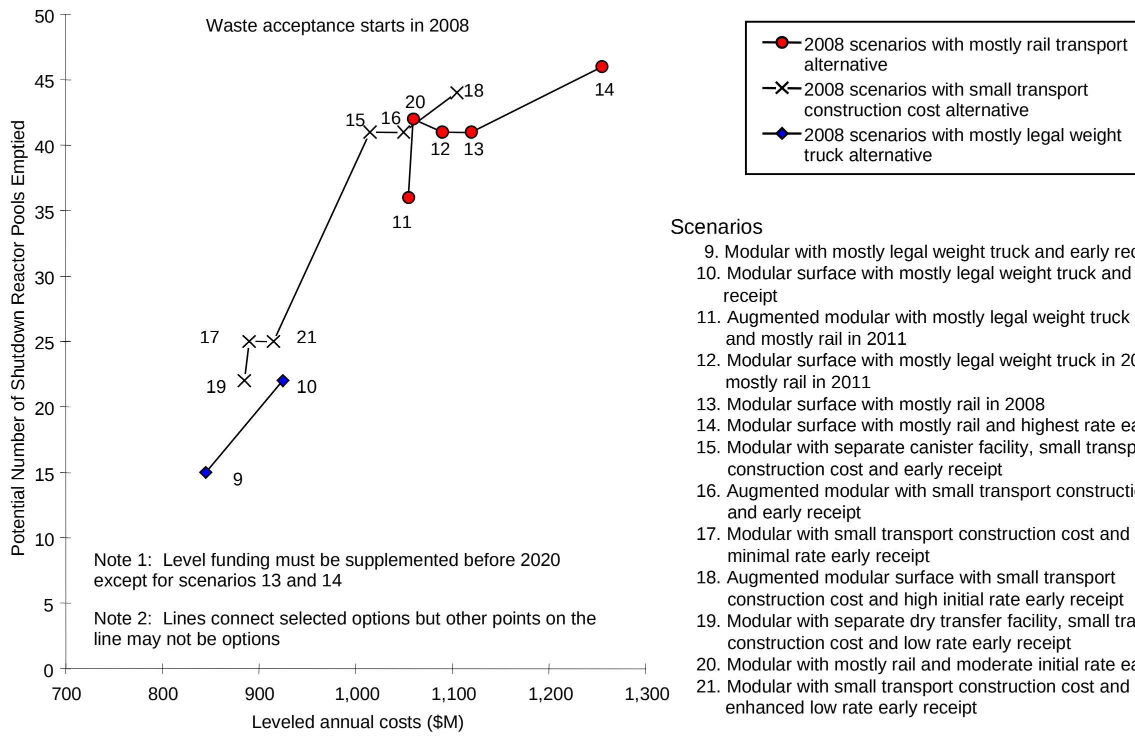
Figure 7-2. Acceptance of Commercial Spent Nuclear Fuel – Adjusted Leveled Annual Costs



Scenarios

9. Modular with mostly legal weight truck and early receipt
10. Modular surface with mostly legal weight truck and early receipt
11. Augmented modular with mostly legal weight truck in 2007 and mostly rail in 2010
12. Modular surface with mostly legal weight truck in 2007 and mostly rail in 2010
13. Modular surface with mostly rail in 2007
14. Modular surface with mostly rail and highest rate early receipt
15. Modular with separate canister facility, small transport construction cost and early receipt
16. Augmented modular with small transport construction cost and early receipt
17. Modular with small transport construction cost and minimal rate early receipt
18. Augmented modular surface with small transport construction cost and high initial rate early receipt
19. Modular with separate dry transfer facility, small transport construction cost and low rate early receipt
20. Modular with mostly rail and moderate initial rate early receipt
21. Modular with small transport construction cost and enhanced low rate early receipt

Figure 7-3. Potential Capability to Pick Up Commercial Spent Nuclear Fuel from Shutdown Reactors – 2007 Pickup



Scenarios

9. Modular with mostly legal weight truck and early receipt
10. Modular surface with mostly legal weight truck and early receipt
11. Augmented modular with mostly legal weight truck in 2008 and mostly rail in 2011
12. Modular surface with mostly legal weight truck in 2008 and mostly rail in 2011
13. Modular surface with mostly rail in 2008
14. Modular surface with mostly rail and highest rate early receipt
15. Modular with separate canister facility, small transport construction cost and early receipt
16. Augmented modular with small transport construction cost and early receipt
17. Modular with small transport construction cost and minimal rate early receipt
18. Augmented modular surface with small transport construction cost and high initial rate early receipt
19. Modular with separate dry transfer facility, small transport construction cost and low rate early receipt
20. Modular with mostly rail and moderate initial rate early receipt
21. Modular with small transport construction cost and enhanced low rate early receipt

Figure 7-4. Potential Capability to Pick Up Commercial Spent Nuclear Fuel from Shutdown Reactors – 2008 Pickup

Table 7-3. Total Naval Spent Nuclear Fuel, U.S. Department of Energy Spent Nuclear Fuel, High-Level Waste with Immobilized Plutonium, and High-Level Waste without Immobilized Plutonium, with Early Receipt

Scenario for early receipt in 2007	**Canisters of Naval SNF received from 2007 to 2020**		**Canisters of DOE SNF received from 2010 to 2020**		**Canisters of High-Level Waste with Immobilized Plutonium received from 2010 to 2020**		**Canisters of High-Level Waste without Immobilized Plutonium received from 2010 to 2020**	
Start of Pickup	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**
9: Modular with mostly legal weight truck and early receipt	80	65	133	0	635	635	1,310	955
10: Modular surface with mostly legal weight truck and early receipt	98	83	261	103	635	635	1,361	1,160
11: Augmented modular with mostly legal weight truck in 2007 and mostly rail in 2010	135	120	368	261	635	635	1,616	1,361
12: Modular surface with mostly legal weight truck in 2007 and mostly rail in 2010	135	120	885	698	635	635	2,521	2,126
13: Modular surface with mostly rail in 2007	135	120	885	698	635	635	2,521	2,126
14: Modular surface with mostly rail and highest rate early receipt	135	120	885	698	635	635	2,521	2,126
15: Modular with separate canister facility, small transport construction cost and early receipt	135	120	142	0	635	635	1,235	955
16: Augmented modular with small transport construction cost and early receipt	135	120	142	0	635	635	1,235	955
17: Modular with small transport construction cost and minimal rate early receipt	135	120	344	237	635	635	1,616	1,361
18: Augmented modular surface with small transport construction cost and high initial rate early receipt	135	120	885	698	635	635	2,521	2,126
19: Modular with separate dry transfer facility, small transport construction cost and low rate early receipt	90	75	118	0	635	635	1,235	955
20: Modular with mostly rail and moderate initial rate early receipt	135	120	885	698	635	635	2,521	2,126
21: Modular with small transport construction cost and enhanced low rate early receipt	135	120	237	92	635	635	1,361	1,105

Life cycle costs are shown for each scenario in Figure 7-5. The following relationships were observed:

- CRWMS total system life cycle costs are similar for all of the early receipt scenarios. The costs differ by less than 6 percent.

- Early receipt scenario life cycle costs are more than life cycle costs for the reference program scenario. The amount of increase is between 1 and 6 percent.

- Increases in funding levels have a small effect on decreasing societal costs for early receipt scenarios. The decrease is approximately 7 percent for an increase in leveled annual funding from $845M to $1255M.

The amount of waste placed into storage at the repository from 2007 through 2020 is shown in Figure 7-6. The relationship illustrated in Figure 7-6 is that the largest storage requirements occur in scenarios that employ the 5,000 MTHM subsurface module and the surface facilities and Nevada transportation needed for high-rate receipt. This relationship is illustrated by scenarios 15 and 16, which require more repository storage than any other scenario.

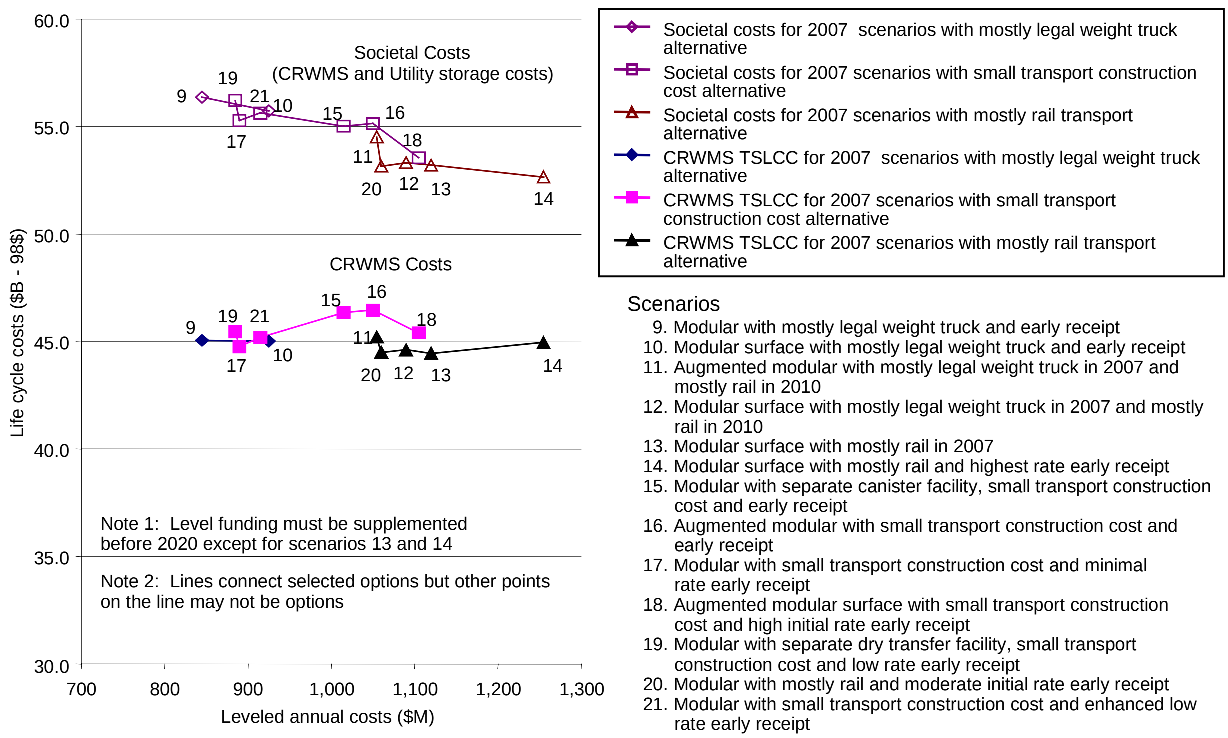


Figure 7-5. Life Cycle Costs

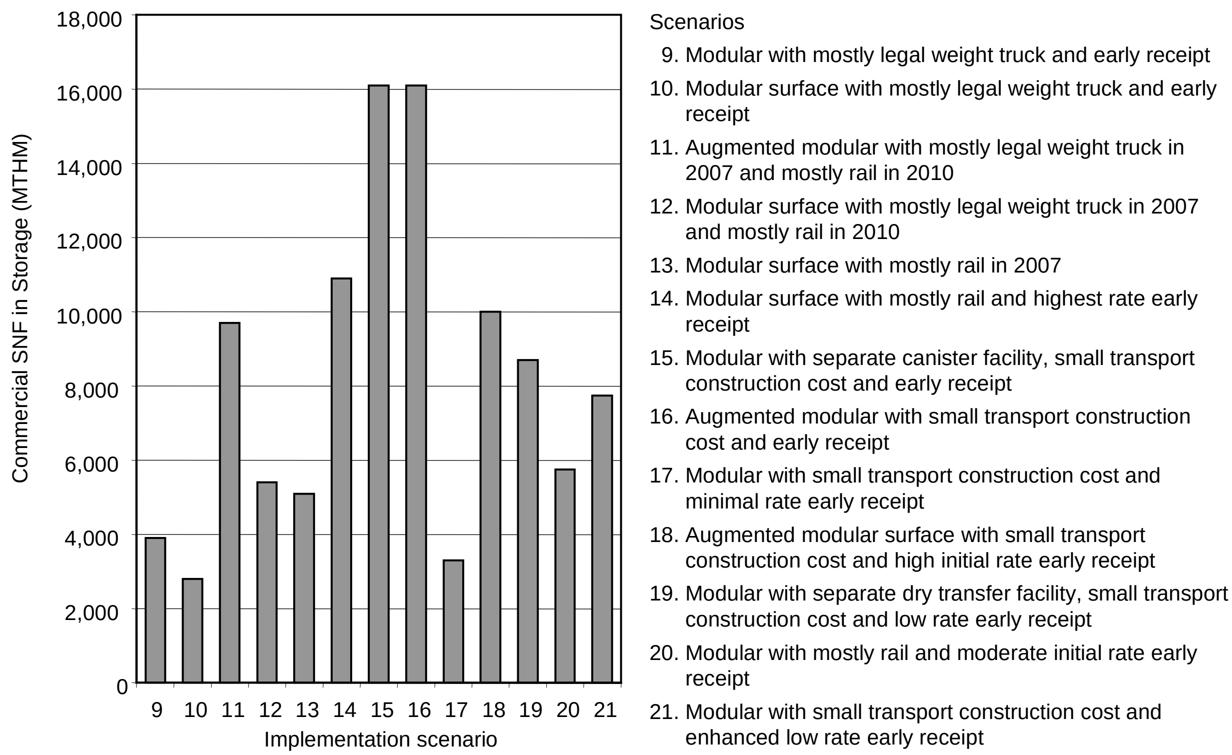


Figure 7-6. Storage Needed for Commercial Spent Nuclear Fuel in 2020

As discussed in Section 2.1, none of the scenarios include retrieval of the waste from storage and emplacement underground until after 2020. If, however, SNF were to be removed from storage concurrent with receipt operations between 2010 and 2020, the amount of waste received from the utilities might be decreased in some scenarios. Decreases would occur if the capacity of the facilities were less than needed for maintaining both desired receipt rates and recovery of SNF from storage. Such impacts have not yet been analyzed.

7.3 SELECTED CASES

Five scenarios were selected for further analysis:

- Scenario 17: Modular with small transport construction cost and minimal rate early receipt
- Scenario 18: Augmented modular surface with small transport construction cost and high rate early receipt
- Scenario 19: Modular with separate dry transfer facility, small transport construction cost and low rate early receipt
- Scenario 20: Modular with mostly rail and moderate rate early receipt

- Scenario 21: Modular with small transport construction cost and enhanced low rate early receipt.

These scenarios were chosen for an evaluation of the following potential changes to the program:

- Early waste receipt at the repository surface facilities beginning in 2007
- Use of the small transport construction cost alternative for transportation of waste to the repository
- Augmentation of the capability to transfer canisters to temporary storage
- Annual receipt rates different than the reference rates
- Starting with the surface facility module with the smallest initial construction costs.

The five scenarios differ in the capacity of initial modules, the receipt rate, and the mode of transportation for shipment of waste to the repository. The tradeoffs inherent between early receipt at the repository surface facilities and starting receipt in 2010 can be seen by comparing the costs and effectiveness of the early receipt scenarios with the costs and effectiveness of scenarios 5 and 7. The implications of using the small transport construction alternative instead of the mostly rail alternative are illustrated by comparing scenarios 20 and 21. The implications of using early augmentation of the capability to receive and transfer canisters to temporary storage are shown by comparing evaluations of scenarios 18 and 21. The implications of choosing the magnitudes of receipt rates are illustrated by comparing evaluations of scenarios 17 and 21, and scenarios 18 and 21.

Scenarios 17, 20, and 21 are scenarios that employ the small waste handling module, the small 5,000 MTHM underground module, and Nevada transport capable of using large transportation casks to support 3,000 MTHM per year of commercial SNF. Nevada transport is the small transport construction cost alternative for scenarios 17 and 21, and is mostly rail for scenario 20. Scenarios 17 and 21 differ in the rates of commercial SNF receipt. Scenario 21 rates are tailored to decrease the need for new utility dry storage sites. Scenario 17 rates are smaller than those of scenario 21 between 2008 and 2016.

Scenario 18 is a high effectiveness case. The first modules of scenario 18 include the augmented WHB-1 and the reference underground facility. Nevada transport for scenario 18 is the small transport construction cost alternative.

Scenario 19 is the lowest initial cost scenario with the small transport construction cost alternative. Its initial surface facility module cost is $97M (05$). That cost is substantially less than the other initial modules: the canister transfer module that costs $155M (05$), and the first module of the WHB that costs $593M (05$).

7.3.1 Annual Costs

The annual costs incurred before 2010 are shown in Table 7-4. Figure 7-7 shows the peak annual costs before waste acceptance begins in 2007, the peak annual costs before emplacement begins in 2010, and the average annual costs.

Only scenario 19, which starts with the small enhanced dry transfer facility, has a difference between the peak costs before waste acceptance starts and the peak costs before emplacement begins. The scenario 19 peak costs after waste acceptance starts are larger than before waste acceptance starts because the surface facilities required for emplacement, WHB-1 and WHB-2, are more expensive than the enhanced dry transfer facility. Scenarios 17 and 21 also utilize WHB-1 and WHB-2 for emplacement. Peak costs of scenarios 17 and 21 are less than for scenario 19 because, unlike scenario 19, the enhanced dry transfer facility construction costs are not incurred, and WHB-1 and WHB-2 are completed before costs are incurred for shipping the waste.

The scenario 20 peak cost is greater than the peak costs of scenarios 17 and 21 because the mostly rail alternative is included in scenario 20 and the small transportation construction cost alternative is included in scenarios 17 and 21. Scenario 18 peak costs are the largest of the five early receipt scenarios because (1) the surface and subsurface facilities are more expensive than those in the other scenarios, and (2) the costs for the fleet of transportation casks needed for starting with high-rate waste acceptance are more expensive than the costs for the fleets needed in the other scenarios.

The following are relationships that were obtained from Table 7-4, Table 6-4, and Figure 7-7:

- The total costs before waste emplacement begins in 2010 are similar for early receipt scenarios and the reference program scenario. Scenario 20, which includes the mostly rail alternative, incurs approximately the same costs as the reference program scenario. Scenario 18, which begins with rates of receipt greater than the initial rate for the reference program scenario, requires about 12 percent more expenditure before 2010 than is required by the reference program scenario. Scenarios 17, 19, and 21 require approximately 9 to 12 percent less expenditures before 2010 than required by the reference program.

- Peak annual costs that are incurred by early receipt scenarios before the start of emplacement can be smaller than the peak annual cost incurred by the reference program scenario. The peak costs for scenarios 17, 19, 20, and 21 are 13 to 28 percent smaller than the peak cost before emplacement starts in the reference program scenario.

- The advantage of starting with a small initial facility, such as the enhanced dry storage facility that reduces peak costs before waste acceptance starts, may be offset by the peak costs needed to construct facilities for waste emplacement before 2010.

Table 7-4. Annual Costs from 2004 through 2009 (YOE $M)

Year	Scenario 17: Modular with small transport construction cost and minimal rate early receipt	Scenario 18: Augmented modular surface with small transport construction cost and high initial rate early receipt	Scenario 19: Modular with separate dry transfer facility, small transport construction cost and low rate early receipt	Scenario 20: Modular with mostly rail and moderate initial rate early receipt	Scenario 21: Modular with small transport construction cost and enhanced low rate early receipt
2004	543	552	523	737	552
2005	933	1,117	664	1,128	937
2006	974	1,331	696	1,187	982
2007	803	966	1,047	814	831
2008	879	1,204	1,052	927	951
2009	907	1,231	1,088	930	953
Total for 2004 to 2009	5,038	6,401	5,070	5,723	5,206

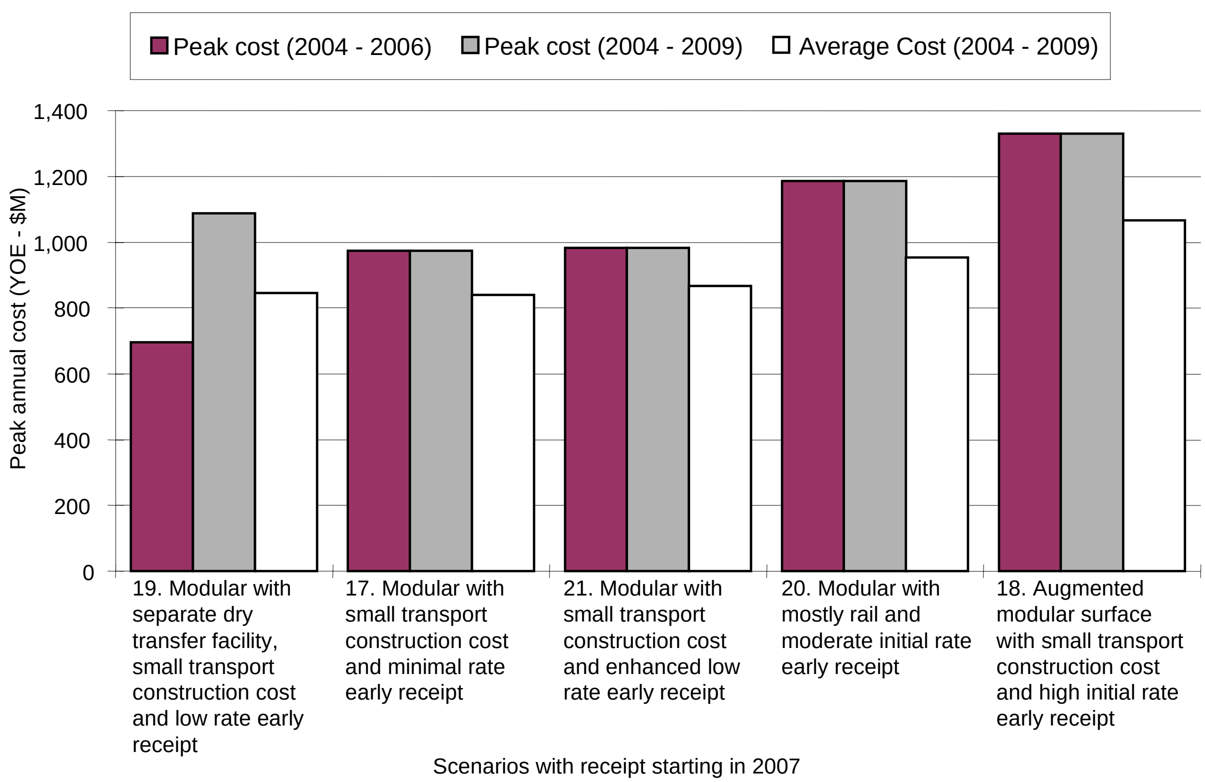


Figure 7-7. Peak Annual Costs from 2004 through 2009

7.3.2 Effectiveness of Waste Acceptance

Analysis results, in addition to those detailed in Section 7.2, are described in this section for two methods of assigning waste acceptance priority to reactors. The baseline method is priority to reactors with the oldest fuel. The second method, described in Sections 2.2.3 and 2.2.4, includes second priority for sites that would otherwise need new dry storage and third priority for shutdown reactors. The effectiveness that could be achieved using the second method is referred to as "potential" effectiveness. The utilities must trade their waste acceptance priority rights in order to achieve the potential effectiveness of the second method of prioritization.

Estimates of effectiveness with the baseline method of waste acceptance prioritization are shown in Table 7-5 for the five selected early receipt scenarios. The effectiveness of scenarios 17, 19, and 21 are similar to that shown in Table 6-5 for the reference program scenario with receipt starting in 2010. The effectiveness of scenario 17 is less than the effectiveness of either scenario 18 or 20. The five scenarios, however, have little effect on the need for new utility dry storage sites (16 would be needed between 2007 and 2015 without waste pickup). The five scenarios also have little effect in removing SNF from the 31 sites that are projected to have shutdown reactors by 2020. Scenarios 18 and 20, however, do reduce the utility costs from the costs estimated for the reference system.

Table 7-5 also includes estimates of effectiveness if early receipt is started in 2008 instead of 2007. The effectiveness is slightly reduced by starting in 2008. For example, utility costs are increased approximately 2 to 5 percent and shutdown reactor site-years are increased from 6 to 9 percent for the scenarios that were analyzed.

The following relationships for effectiveness with the baseline method of waste acceptance prioritization were developed from the estimates of effectiveness provided in Table 7-5 and Table 6-5:

- Minimal rate early receipt provides little advantage in effectiveness over scenarios that start receipt in 2010.

- Higher rate early receipt provides only a modest advantage in effectiveness over scenarios that start in 2010.

- Early receipt with the baseline method of waste acceptance prioritization can empty a small fraction of pools at the 31 sites that are projected to have been shut down for at least 5 years by 2020.

- The effect of starting early receipt in 2008 is a small increase in utility storage costs and the number of new dry storage sites that would be needed.

Table 7-5. Effectiveness with the Baseline Method of Waste Acceptance Prioritization

Effectiveness Measure	Effectiveness from 2007 through 2020									
	Scenario 17: Modular with small transport construction cost and minimal rate early receipt		**Scenario 18: Augmented modular surface with small transport construction cost and high initial rate early receipt**		**Scenario 19: Modular with separate dry transfer facility, small transport construction cost and low rate early receipt**		**Scenario 20: Modular with mostly rail and moderate initial rate early receipt**		**Scenario 21: Modular with small transport construction cost and enhanced low rate early receipt**	
Start of Pickup	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**
Number of new dry storage sites avoided	1	1	4	3	2	1	3	2	2	2
Number of shutdown reactor sites emptied	3	2	5	5	3	2	5	5	3	2
Cumulative site shutdown – years prior to empty pools	1,113	1,188	801	875	1,147	1,222	859	933	1,109	1,184
Utility costs from 1998 – 2020 ($B – 98$)	4.7	4.9	4.0	4.2	4.8	4.9	4.2	4.4	4.7	4.8
Commercial SNF in storage at the repository through 2009 (MTHM)	1,900	1,000	4,400	2,400	1,700	1,000	2,450	1,250	2,450	1,250
Commercial SNF in storage through 2020 (MTHM)	3,300	3,300	10,000	10,000	8,700	8,700	5,750	5,750	7,750	7,750

Estimates of potential effectiveness with the second method of waste acceptance prioritization are shown in Table 7-6. The potential effectiveness that could be obtained with the second method of waste acceptance priority is substantially greater than the effectiveness that would be obtained with the baseline method.

Table 7-6 also includes estimates of the potential effectiveness if early receipt is started in 2008 instead of 2007. The potential effectiveness is degraded a small amount. For example, utility costs are increased approximately 5 to 14 percent and shutdown reactor site-years are increased from 7 to 25 percent for the scenarios that were analyzed.

Table 7-6. Potential Effectiveness with the Second Method of Waste Acceptance Prioritization

Effectiveness Measure	Effectiveness from 2007 through 2020									
	Scenario 17: Modular with small transport construction cost and minimal rate early receipt		**Scenario 18: Augmented modular surface with small transport construction cost and high initial rate early receipt**		**Scenario 19: Modular with separate dry transfer facility, small transport construction cost and low rate early receipt**		**Scenario 20: Modular with mostly rail and moderate initial rate early receipt**		**Scenario 21: Modular with small transport construction cost and enhanced low rate early receipt**	
Start of Pickup	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**
Potential number of new dry storage sites avoided	4	2	16	14	7	7	16	13	16	13
Potential number of shutdown reactor sites emptied	23	20	31	29	20	16	29	28	19	16
Potential cumulative site shutdown – years prior to empty pools	590	664	294	369	624	709	355	412	644	690
Potential utility costs from 1998 – 2020 ($B – 98$)	4.2	4.4	2.9	3.3	4.0	4.2	3.1	3.5	3.8	4.0
Commercial SNF in storage at the repository through 2009 (MTHM)	1,900	1,000	4,400	2,400	1,700	1,000	2,450	1,250	2,450	1,250
Commercial SNF in storage through 2020 (MTHM)	3,300	3,300	10,000	10,000	8,700	8,700	5,750	5,750	7,750	7,750

The early receipt scenarios that start in 2007 have the potential to avoid as many as nine more new utility dry storage sites than scenarios that start in 2010, as shown in Section 2.2.4. If early receipt scenarios start in 2008 instead, they have the potential to avoid as many as seven more new utility sites than scenarios that start in 2010. The potential ability of an implementation scenario to avoid new utility dry storage sites is significantly affected by tailoring the receipt rates in the first few years of receipt. The superior potential effectiveness of scenario 21 is achieved primarily by a 39 percent increase in receipt rates over those of scenario 17 between 2008 and 2012. The 39 percent increase in rates of receipt for 5 early years provides a 400 percent increase in the potential to limit the utilities' needs for new dry storage sites.

The site-years before reactor pools are emptied are shown in Figure 7-8 for early receipt scenarios that start receipt in 2007 and for scenarios that start receipt in 2010. The figure includes estimates for each of the two methods assumed for prioritizing waste acceptance as

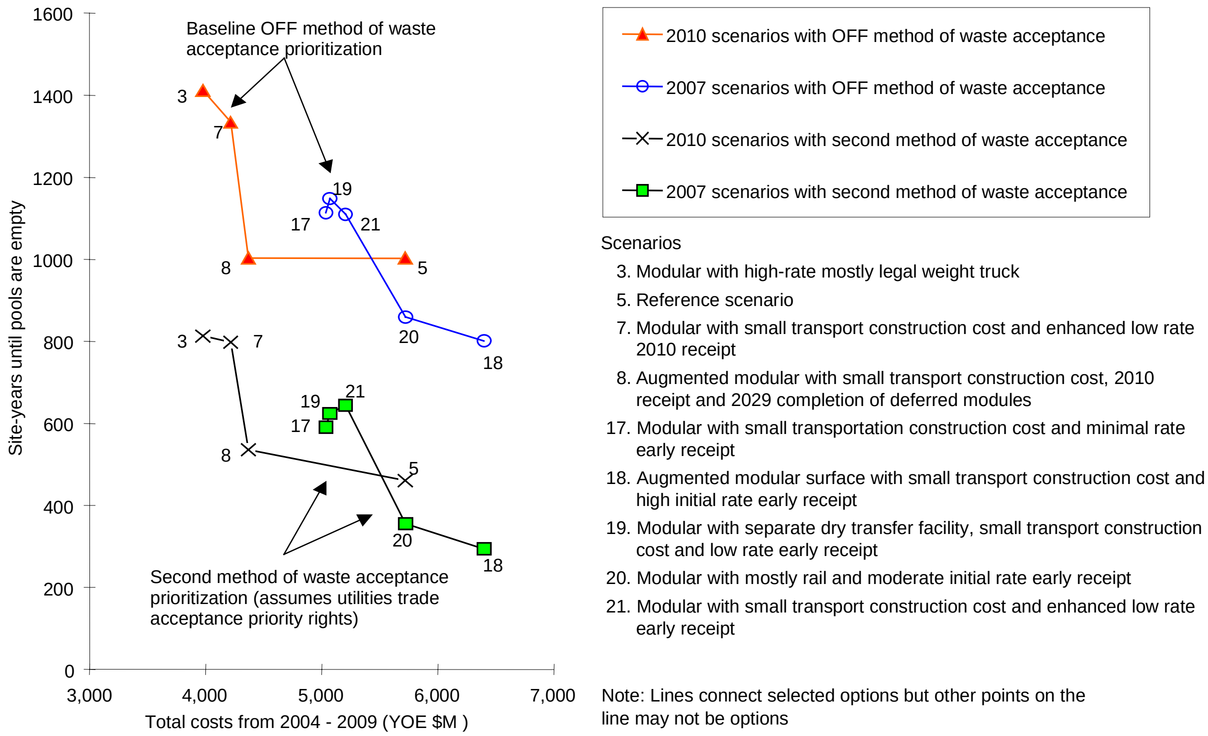


Figure 7-8. Cumulative Site Years that Spent Nuclear Fuel Remains at Shutdown Reactor Sites

described in Section 2.2.3. The relationships displayed in this figure show that high rates for waste pickup, not just the fact that waste pickup starts early, is the primary reason that the site-years of early receipt scenarios can be less than the site-years of scenarios that start in 2010. The relationships in the figure also show that the method of waste acceptance prioritization has a larger impact on site-years than starting receipt 3 years earlier than the reference program scenario.

One advantage of early receipt is that it can advance the date when 3,000 MTHM per year is achieved. The site-year effectiveness, however, is relatively insensitive to the amount of waste picked up from 2007 through 2009 because the number of shutdown sites is projected to increase substantially during the period from 2010 through 2020. The importance of the rates of waste pickup is illustrated by scenarios 20 and 18. Scenarios 20 and 18 have substantially better site-year effectiveness than the other early receipt scenarios. They also have the largest early expenditure (the total expenditures from 2004 through 2009). This expenditure supports receipt rates that increase to 3,000 MTHM per year by 2013 or 2014, approximately the same time that the reference scenario achieves 3,000 MTHM per year. The other scenarios, 17, 19, and 21, however, don't achieve 3,000 MTHM per year until 2018 or 2019.

The importance of the method of waste acceptance prioritization is illustrated by scenarios 5 and 20. The scenarios have similar rates of waste pickup. Scenario 5, the reference program scenario, attains 3,000 MTHM per year in 2014, and scenario 20, an early receipt scenario, attains 3,000 MTHM per year in 2013. As shown in Figure 7-8, the reduction in site-years that could be obtained by choosing early receipt scenario 20 instead of scenario 5, is much less than the reduction in site-years that could be obtained if the utilities trade acceptance priority rights consistent with the second method of waste acceptance prioritization.

The following are summary conclusions from the analyses of effectiveness:

- The potential ability of an implementation scenario to avoid new utility dry storage sites is significantly affected by tailoring the receipt rates in the first few years of receipt.

- The rates of waste pick up, not the fact that waste pickup starts earlier than 2010, is the primary reason that site-years and utility storage costs are reduced. Earlier attainment of the target receipt rate of 3,000 MTHM per year, which may be a consequence of early receipt, leads to reduced site-years.

- Site-years and utility costs are reduced more by providing priority to shutdown reactors than by starting receipt early.

- Both early receipt that starts in 2007 and trading of acceptance rights by utilities are required to provide the capability to avoid 12 of the projected 16 new dry storage sites.

- If early receipt starts in 2008 instead of 2007, only 14 of the projected 16 new dry storage sites could be avoided. Trading of acceptance rights by utilities would be required in order to avoid the need for 11 of those sites for the scenarios considered in this section.

7.3.3 Life Cycle Costs

Life cycle costs for both the CRWMS and the utilities are shown in Tables 7-7 and 7-8. The costs in Table 7-7 would be incurred if the baseline waste acceptance prioritization were to be used, and the costs in Table 7-8 would be incurred if the second method of waste acceptance prioritization were to be used. The CRWMS life cycle costs are the same for both methods of waste acceptance priority, but the utility life cycle costs are larger for the baseline method. Utility costs are for dry storage and pool maintenance after reactor shutdown, as described in Section 2. Societal costs are the sum of utility costs and CRWMS life cycle costs.

Table 7-7. Life Cycle Costs with the Baseline Method of Waste Acceptance

Scenario	Total Costs ($B – 98$) (Not discounted)			Present value of Costs ($B – 98$) (2.3% discount rate)		
	CRWMS Total System Life Cycle Costs	Utility Costs	Societal Costs	CRWMS Total System Life Cycle Costs	Utility Costs	Societal Costs
17: Modular with small transport construction cost and minimal rate early receipt	$44.7	$10.5	$55.3	$20.5	$6.3	$26.8
18: Augmented modular surface with small transport construction cost and high initial rate early receipt	$45.4	$8.1	$53.5	$21.7	$5.1	$26.7
19: Modular with separate dry transfer facility, small transport construction cost and low rate early receipt	$45.5	$10.7	$56.2	$20.5	$6.4	$26.9
20: Modular with mostly rail and moderate initial rate early receipt	$44.5	$8.6	$53.1	$21.1	$5.3	$26.5
21: Modular with small transport construction cost and enhanced low rate early receipt	$45.2	$10.4	$55.6	$20.6	$6.2	$26.8

Table 7-8. Life Cycle Costs with the Second Method of Waste Acceptance

Scenario	Total Costs ($B – 98$) (Not discounted)			Present value of Costs ($B – 98$) (2.3% discount rate)		
	CRWMS Total System Life Cycle Costs	Utility Costs	Societal Costs	CRWMS Total System Life Cycle Costs	Utility Costs	Societal Costs
17: Modular with small transport construction cost and minimal rate early receipt	$44.7	$8.1	$52.8	$20.5	$5.0	$25.5
18: Augmented modular surface with small transport construction cost and high initial rate early receipt	$45.4	$4.7	$50.1	$21.7	$3.2	$24.8
19: Modular with separate dry transfer facility, small transport construction cost and low rate early receipt	$45.5	$8.3	$53.7	$20.5	$5.1	$25.6
20: Modular with mostly rail and moderate initial rate early receipt	$44.5	$5.4	$49.9	$21.1	$3.5	$24.7
21: Modular with small transport construction cost and enhanced low rate early receipt	$45.2	$8.0	$53.2	$20.6	$4.9	$25.5

Life cycle costs for the CRWMS and utility storage are shown in Figures 7-9 and 7-10. Figure 7-9 shows the results with the baseline method of waste acceptance prioritization, and Figure 7-10 shows the results with the second method of waste acceptance prioritization. The results are shown for both early receipt scenarios and scenarios with receipt starting in 2010. The following observations are based on the relationships illustrated in the figures and the data shown in Tables 7-7 and 7-8:

- Increased investment (expenditures from 2004 to 2009) in the CRWMS decreases both undiscounted and discounted utility and societal life cycle costs.

- The method of waste acceptance prioritization could be important to the reduction of utility storage costs. The estimated reduction is approximately 20 percent to 40 percent for the early receipt scenarios considered. The effect is of similar magnitude when the time value of money is considered.

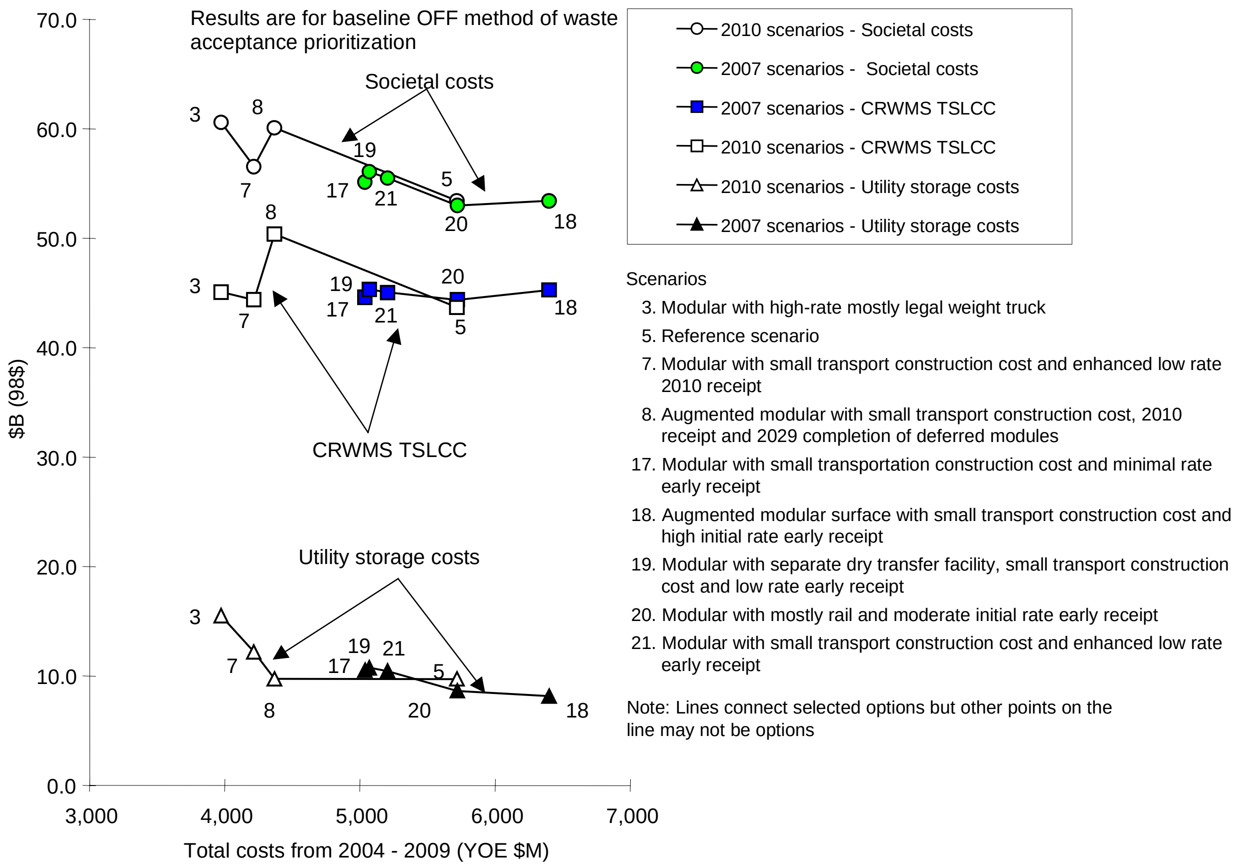
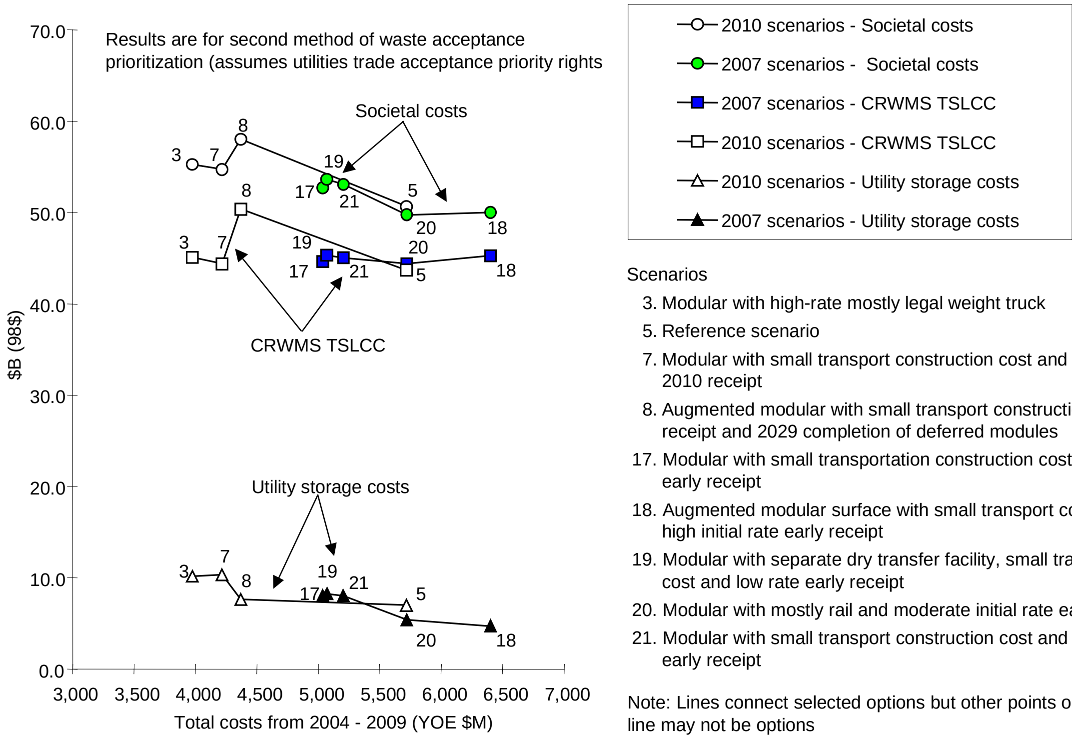


Figure 7-9. Life Cycle Costs with Baseline Oldest Fuel First Method of Waste Acceptance



Scenarios

3. Modular with high-rate mostly legal weight truck
5. Reference scenario
7. Modular with small transport construction cost and enhanced low rate 2010 receipt
8. Augmented modular with small transport construction cost, 2010 receipt and 2029 completion of deferred modules
17. Modular with small transportation construction cost and minimal rate early receipt
18. Augmented modular surface with small transport construction cost and high initial rate early receipt
19. Modular with separate dry transfer facility, small transport construction cost and low rate early receipt
20. Modular with mostly rail and moderate initial rate early receipt
21. Modular with small transport construction cost and enhanced low rate early receipt

Note: Lines connect selected options but other points on the line may not be options

Figure 7-10. Life Cycle Costs with Second Method of Waste Acceptance

7.3.4 Regulatory Impacts and Risks

Regulatory impacts and risks could occur in three areas: (1) the uncertainty in the timeliness of required modifications of 10 CFR Part 60 to provide for receipt of waste before the facilities for waste emplacement are constructed and licensed, (2) uncertainties in the need for changes in 10 CFR Part 60.41 to allow partial completion of surface facilities at the time when the license to receive and possess waste is granted, and (3) the uncertainties associated with the small transport construction cost alternative. The uncertainties with the small transport construction cost alternative include uncertainty in obtaining a short branch rail line or in continually obtaining daily permits for full-scale heavy-haul shipments to and from the MGR or to and from a short branch rail line that goes to the MGR. Regulatory impacts and risks are shown in Table 7-9.

Table 7-9. Regulatory Impacts and Risks

Impacts and Risk Areas	**Scenario 17: Modular with small transport construction cost and minimal rate early receipt**	**Scenario 18: Augmented modular surface with small transport construction cost and high initial rate early receipt**	**Scenario 19: Modular with separate dry transfer, small transport facility construction cost and low rate early receipt**	**Scenario 20: Modular with mostly rail and moderate initial rate early receipt**	**Scenario 21: Modular with small transport construction cost and enhanced low rate early receipt**
Regulatory change needed for early receipt before facilities for waste emplacement are constructed and licensed	X	X	X	X	X
Uncertainties in the need for changes in 10 CFR Part 60.41 to allow partial completion of surface facilities at the time when the license to receive and possess waste is granted	X	X	X	X	X
Uncertainties associated with the small transport construction cost alternative	X	X	X		X